

## RIVERS AND FLOODS

[River and Flood Division, MONTROSE W. HAYES, in charge]

By RICHMOND T. ZOCH

The most disastrous floods during July were those in New York and northeastern Pennsylvania. Record breaking stages were reached in practically all of the small streams there, causing the loss of 52 lives (40 in New York, and 12 in Pennsylvania), and about \$26,000,000 in property, \$25,000,000 being in New York State.

The following is an account of the meteorological conditions which caused the flood-producing rains, prepared by Charles L. Mitchell of the Weather Bureau in Washington:

The heavy rains were due, not to any single cause, but to a combination of causes. At 8 p. m. of July 3 a well-defined disturbance was moving eastward over the Hudson Bay region, and an ill-defined, slow-moving disturbance was over the Rocky Mountain region and the Plains States. At the same time a mass of polar air had begun to move southward over northern Canada. During the next 24 hours the northern disturbance had moved rapidly east-southeastward to the lower St. Lawrence Valley, the western disturbance had assumed more definite form and was central over South Dakota, and the polar continental air had overspread the Hudson Bay region. By the morning of the 5th the center of the northeastern disturbance was over the Gulf of St. Lawrence and the Dakota disturbance was over Minnesota and extreme western Ontario, moving northeastward. However, its further advance in that direction was blocked by a wedge of the polar continental air that had by this time pushed southeastward over James Bay and northern Ontario. With the center of the northern high pressure area still west of Hudson Bay, the disturbance was not merely blocked in its northeastward movement, but was carried along by the general drift of the upper air toward the east-southeast until the morning of the 7th, when the center was near Buffalo, N. Y. Meanwhile, the front of the polar continental air mass which had reached northern New England and extreme northern New York the evening of the 5th, pushed southward and southwestward, and at 8 p. m. of the 7th this cold front extended from a short distance south of New Haven, Conn., northwestward to Lake Ontario, through or very close to the area over which excessive rain was then falling and continued to fall through the night. For the second time the disturbance was blocked and it made no further eastward progress; but its center drifted slowly southward during the next 24 hours and merged with another disturbance that moved northeastward from Georgia to the New Jersey coast where it was centered the evening of the 8th. Due to this unusual meteorological situation a mass of warm and very moist tropical maritime air moved north-northwestward over eastern and central New York, while at the same time a mass of polar continental air was moving southeastward over the Lake region and its front had reached eastern Lake Erie by 8 p. m. of the 7th. The inevitable result was that for a period of many hours, by the physical processes of convergence and forced convection, the continuous stream of tropical maritime air was lifted rapidly; and heavy and prolonged rainfall occurred over a considerable area, of which Cortland appeared to be the center. Wherever the tropical maritime air mass was forced to rise over elevated areas the rainfall was naturally even heavier than over other sections where the wind was not upslope.

The following comments of John C. Fisher, Weather Bureau Office, Ithaca, N. Y., are of interest:

Thunderstorms were general over south-central New York during the period July 6-9, inclusive, with the heaviest precipitation recorded on the 7th and 8th. Over an area extending from northern Steuben County eastward to northern Delaware County

new records for 24-hour precipitation were established at all stations. The heaviest rainfall occurred over a still more limited area extending from Keuka Lake to central Chenango County, in extent approximately 100 miles from west to east and 15 to 20 miles from north to south, and covering the divide between Finger Lake drainage to the north and Susquehanna and Delaware drainage to the south; here from 9 to over 10 inches fell during the 2-day period July 7-8 inclusive.

The distribution of rainfall was unusually uniform for thunderstorm precipitation, but naturally there was considerable variation in amount. Observations indicate that while a few sections escaped serious damage, in other districts the rainfall was undoubtedly much heavier than recorded by any of the standard gages.

The only automatic rain gage in the area of maximum rainfall is located at Ithaca; so this record, which shows the time of fall of each .01 inch, is of considerable interest. Previous records of severe thunderstorms show greater intensities of rainfall for periods of from 5 minutes to 2 hours; but the former 24-hour maximum amount was 4.70 inches, while 7.90 was recorded between 4 p. m. of July 7 and 4 p. m. of July 8, 1935. If this record is indicative of conditions throughout the area, the rainfalls were not of the type commonly characterized as "cloudbursts"; in other words, while the amount of precipitation falling in 24 hours and 48 hours exceeded all previous records, the rate of fall was not unusually high at any time.

In this portion of New York State the topography is rough, with many small streams discharging steeply into glacial valleys. The unprecedented rainfall brought many of these streams to flood peaks so sudden and high that people were caught practically unaware, trapped in houses, automobiles, and cottages on the shores of the Finger Lakes. During the early hours of July 8, creeks whose summer flow is usually insignificant discharged water many feet deep through the centers of Urbana, Hammondsport, Watkins Glen, Montour Falls, Myers, Trumansburg, Marathon, Lisle, Willett and other towns and villages. Trees, buildings, and other debris jammed bridges and culverts, streams were diverted, roads washed out, houses demolished, fields deeply gullied or buried under gravel, railroads washed out, and bridges carried away.

There was also great damage through inundation. The run-off to the north submerged thousands of acres of highly productive muck and bottom lands, while the Canisteo River at Hornell and the Chenango at Binghamton flooded residential and business sections, as was also the case at Ithaca, Bath, and many other towns in a lesser degree.

Estimates of total damage vary, and some items can hardly be approximated; however, it is considered that \$25,000,000 is conservative. The loss to State highways was approximately \$3,000,000, of which \$1,750,000 was damage to bridges; damage to town and county roads was very probably greater, with some 540 bridges of a span greater than 5 feet to be replaced. The railroads, excluding loss of business, suffered property loss in excess of \$1,250,000. Public utilities had heavy damage, as did the State parks at Watkins Glen, Enfield, and Taughannock Falls. Damage to urban property was in the millions, but no accurate figures are available. Suburban damage, including buildings, livestock, destruction of crops, loss of use of land, soil erosion, etc., was probably greater than any of the above items.

While the loss of 40 lives was directly attributable to the floods, prompt action of the proper authorities provided food and shelter for those driven from their homes, and also prevented any outbreaks of water-borne diseases.

All streams in the Mississippi System passed below flood stage during July. All of the important features of these floods have been mentioned in previous issues of the MONTHLY WEATHER REVIEW.

Table of flood stages in July 1935

[All dates are in July unless otherwise specified]

River and station	Flood stage	Above flood stages— dates		Crest	
		From—	To—	Stage	Date
ATLANTIC SLOPE DRAINAGE					
Lackawaxen: Hawley, Pa.-----	<i>Feet</i> 6	10	10	6.8	10
Lehigh: Lehigh, Pa.-----	9	10	10	13.0	10
Schuylkill: Reading, Pa.-----	7	9	11	15.8	10
Chemung: Corning, N. Y.-----	16	8	9	20.15	8
Susquehanna:					
Oneonta, N. Y.-----	12	8	11	16.7	8
Bainbridge, N. Y.-----	11	8	10	18.5	8
Binghamton, N. Y.-----	14	9	10	17.7	9
Towanda, Pa.-----	16	9	10	21.0	9
Wilkes-Barre, Pa.-----	22	10	11	25.6	10
Tar: Greenville, N. C.-----	12	16	17	12.1	17
Savannah: Ellenton, S. C.-----	14	22	27	15.8	26, 27
MISSISSIPPI SYSTEM					
Upper Mississippi Basin					
Mississippi:					
Keokuk, Iowa-----	12	6	8	13.0	7
Quincy, Ill.-----	14	7	8	14.4	7, 8
Hannibal, Mo.-----	13	1	9	14.4	8
Louisiana, Mo.-----	12	2	10	12.1	8
Alton, Ill.-----	21	1	7	22.0	4
Chester, Ill.-----	27	1	7	27.7	2
Missouri Basin					
Solomon: Niles, Kans.-----	24	3	3	24.4	3
Smoky Hill:					
Lindsborg, Kans.-----	21	4	4	23.6	4
Selina, Kans.-----	20	2	3	21.0	3
Enterprise, Kans.-----	26	6	6	20.0	6
		4	6	27.2	5
Ohio Basin					
Tuscarawas: Coshocton, Ohio-----	11	5	5	11.5	5
Little Miami: Kings Mills, Ohio-----	17	25	25	18.8	25

Table of flood stages in July 1935—Continued

[All dates are in July unless otherwise specified]

River and station	Flood stage	Above flood stages— dates		Crest	
		From—	To—	Stage	Date
<i>Arkansas Basin</i>					
Arkansas:	<i>Feet</i>			<i>Feet</i>	
Fort Lyon, Colo.-----	5	22	22	6.9	22
Van Buren, Ark.-----	22	2	2	22.5	2
<i>Red Basin</i>					
Red:					
Grand Ecore, La.-----	33	May 26	4	35.7	1
Alexandria, La.-----	32	May 8	11	41.3	June 4
<i>Lower Mississippi Basin</i>					
Mississippi:					
Vicksburg, Miss.-----	43	June 8	12	44.7	4.5
Natchez, Miss.-----	46	June 1	17	49.3	4-7
Angola, La.-----	46	May 31	19	48.0	4-10
Baton Rouge, La.-----	35	May 30	20	38.4	5-11
Donaldsonville, La.-----	28	June 5	19	30.0	6-11
Reserve, La.-----	22	June 8	17	23.6	9-11
New Orleans, La.-----	17	June 1	13	17.4	8, 9
<i>Atchafalaya Basin</i>					
Atchafalaya:					
Simmesport, La.-----	41	June 4	16	42.5	5-10
Melville, La.-----	37	May 20	20	39.6	4-11
Atchafalaya, La.-----	22	Mar. 15	28	24.7	11-15
WEST GULF OF MEXICO DRAINAGE					
Trinity: Liberty, Tex.-----	25	3	12	25.9	9
Nueces: Cotulla, Tex.-----	15	29	(*)	18.6	30

\* Flood continued into August.

## WEATHER OF THE ATLANTIC AND PACIFIC OCEANS

[The Marine Division, W. F. McDONALD, in Charge]

## NORTH ATLANTIC OCEAN, JULY 1935

By H. C. HUNTER

**Atmospheric pressure.**—The pressure during July averaged greater than normal over most of the North Atlantic Ocean, notably in the region of the British Isles; in the north central and northwestern parts the pressure was less than normal, especially near Iceland, where Reykjavik averaged 0.25 inch less. In the Gulf of Mexico, and eastward to the Bahamas and Bermuda, the pressure was a little less than normal.

Of trustworthy pressure readings so far reported, the highest is 30.61 inches, on the 4th, on the Japanese steamship *Glasgow Maru*, near 48° N., 8° W.; the lowest is 29.23 inches, on the American steamship *Tuscaloosa City*, at 8 a. m., the 13th, near 52° N., 53° W. Table 1 indicates that lower readings than that of the *Tuscaloosa City* were noted at Julianehaab and Reykjavik.

TABLE 1.—Averages, departures, and extremes of atmospheric pressure (sea level) at selected stations for the North Atlantic Ocean and its shores, July 1935

Station	Average pressure	Departure	High-est	Date	Low-est	Date
	Inches	Inch	Inches		Inches	
Julianehaab, Greenland	29.69	—	29.94	28	29.22	11
Reykjavik, Iceland	29.59	—0.25	30.14	29	29.02	15
Lerwick, Shetland Islands	29.91	+ .11	30.27	14	29.41	26
Valencia, Ireland	30.17	+ .19	30.41	25	29.57	19
Lisbon, Portugal	30.09	+ .04	30.16	3, 4, 12	29.93	18
Madeira	30.09	+ .04	30.19	8	29.96	20
Horta, Azores	30.34	+ .07	30.50	25, 26	30.07	31
Belle Isle, Newfoundland	29.86	— .01	30.20	8, 16	29.30	13
Halifax, Nova Scotia	30.04	+ .09	30.36	18	29.62	13
Nantucket	30.00	+ .02	30.38	18	29.67	31
Hatteras	30.03	+ .02	30.36	18	29.69	8
Bermuda	30.17	— .01	30.30	15	30.04	6, 29, 30
Turks Island	30.05	— .02	30.10	13	29.95	16
Key West	30.01	— .02	30.12	29	29.83	7
New Orleans	29.98	— .02	30.15	30	29.75	8

NOTE.—All data based on a. m. observations only, with departures compiled from best available normals related to time of observations, except Hatteras, Key West, Nantucket, and New Orleans, which are 24-hour corrected means.